Linx TECHNOLOGIES

MS Series
Remote Control Decoder
Data Guide

Wireless made simple®

Warning: Some customers may want Linx radio frequency ("RF") products to control machinery or devices remotely, including machinery or devices that can cause death, bodily injuries, and/or property damage if improperly or inadvertently triggered, particularly in industrial settings or other applications implicating life-safety concerns ("Life and Property Safety Situations").

NO OEM LINX REMOTE CONTROL OR FUNCTION MODULE SHOULD EVER BE USED IN LIFE AND PROPERTY SAFETY SITUATIONS. No OEM Linx Remote Control or Function Module should be modified for Life and Property Safety Situations. Such modification cannot provide sufficient safety and will void the product's regulatory certification and warranty.

Customers may use our (non-Function) Modules, Antenna and Connectors as part of other systems in Life Safety Situations, but only with necessary and industry appropriate redundancies and in compliance with applicable safety standards, including without limitation, ANSI and NFPA standards. It is solely the responsibility of any Linx customer who uses one or more of these products to incorporate appropriate redundancies and safety standards for the Life and Property Safety Situation application.

Do not use this or any Linx product to trigger an action directly from the data line or RSSI lines without a protocol or encoder/decoder to validate the data. Without validation, any signal from another unrelated transmitter in the environment received by the module could inadvertently trigger the action.

All RF products are susceptible to RF interference that can prevent communication. RF products without frequency agility or hopping implemented are more subject to interference. This module does not have a frequency hopping protocol built in.

Do not use any Linx product over the limits in this data guide. Excessive voltage or extended operation at the maximum voltage could cause product failure. Exceeding the reflow temperature profile could cause product failure which is not immediately evident.

Do not make any physical or electrical modifications to any Linx product. This will void the warranty and regulatory and UL certifications and may cause product failure which is not immediately evident.

Ordering Information

Ordering Information	
Part Number	**Description**
LICAL-ENC-MS001	MS Encoder
LICAL-DEC-MS001	MS Decoder
MDEV-LICAL-MS	MS Master Development System
MS decoders are shipped in reels of 1,600	

Figure 2: Ordering Information

Absolute Maximum Ratings

Absolute Maximum Ratings				
Supply Voltage V_{CC}	–0.3	to	+6.5	VDC
Any Input or Output Pin	–0.3	to	V_{CC} + 0.3	VDC
Max. Current Sourced by Output Pins		25		mA
Max. Current Sunk by Input Pins		25		mA
Max. Current Into V_{CC}		250		mA
Max. Current Out Of GND		300		mA
Operating Temperature	–40	to	+85	ºC
Storage Temperature	–65	to	+150	ºC
Exceeding any of the limits of this section may lead to permanent damage to the device. Furthermore, extended operation at these maximum ratings may reduce the life of this device.				

Figure 3: Absolute Maximum Ratings

Timings

Encoder SEND to Decoder Activation Times (ms)			
Baud Rate	**Initial Start-Up**	**After Valid Rx**	**With RX_PDN (Worst Case)**
2,400	72.62	38.62	600 + 72.62
9,600	22.42	12.42	300 + 22.42
19,200	13.80	7.30	150 + 13.80
28,800	11.00	6.00	150 + 11.00

Figure 4: Encoder SEND to Decoder Activation Times (ms)

Pin Assignments

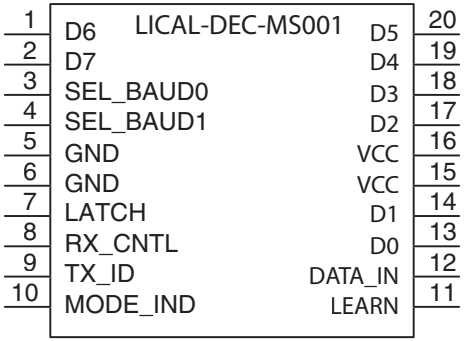

Figure 6: MS Series Deccoder Pin Assignments

Pin Descriptions

Pin Number	Name	I/O	Description
1, 2, 13, 14, 17–20	DO–D7	O	Data Output Lines. These lines reproduce the state of the encoder's data lines upon reception of a valid packet.
3	SEL_BAUD0	I	Baud Rate Selection Line 0. This line along with SEL_BAUD1 sets the baud rate of the serial data stream to one of 4 possible rates. The rate must be set before power on.
4	SEL_BAUD1	I	Baud Rate Selection Line 1. This line along with SEL_BAUD0 sets the baud rate of the serial data stream to one of 4 possible rates. The rate must be set before power on.
5, 6	GND		Ground
7	LATCH	I	Set Latched Outputs. If this line is low, then the data outputs are momentary (active for as long as a valid signal is received). If this line is high, the outputs are latched (when a signal is received to make a particular data line high, it remains high until another transmission is received instructing it to go low).
8	RX_CNTL	I/O	External Receiver Control Line. This line can be used to automatically power on and off a receiver. It powers the receiver down for ten times as long as it is powered on. The times are determined by the selected baud rate.

Design Considerations

The Linx MS Series encoders and decoders are designed for remote control applications. They provide an easy way to securely register button presses or switch closures over a wireless link. The encoder side turns the status of eight parallel input lines into a secure, encoded, serial bit-stream output intended for transmission via an RF or infrared link. Once received, the decoder decodes, error checks, and analyzes the transmission. If the transmission is authenticated, the output lines are set to replicate the status of the lines on the encoder.

Prior to the arrival of the Linx MS Series, encoders and decoders typically fell into one of two categories. First were older generation, low-security devices that transmitted a fixed address code, usually set manually with a DIP switch. These address lines frequently caused the user confusion when trying to match a transmitter to a receiver. Another disadvantage was the possibility that address information could be captured and later used to compromise the system.

These concerns resulted in the development of a second type of encoder / decoder that focused on security and utilized encryption to guard against code cracking or code grabbing. Typically, the encoding of each transmission changes based on complex mathematical algorithms to prevent someone from replicating a transmission. These devices gained rapid popularity due to their high security and the elimination of manual switches; however, they imposed some limitations of their own. Such devices typically offer a limited number of inputs, the transmitter and receiver can become desynchronized, and creating relationships and associations between groups of transmitters and receivers is difficult.

The Linx product line, which includes the MS and HS Series, is the first product line to offer the best of all worlds. Both series accept up to eight inputs, allowing a large number of buttons or contacts to be connected. The devices also allow relationships among multiple encoders and decoders to be easily created. Security is well provided for. The MS Series uses a random fixed word with 2^{24} possible combinations to give a high level of uniqueness and a reasonable level of security. For applications requiring the highest security, the HS Series, which employs tri-level, maximum-security encryption, should be considered.

Encoder transmission protocol and methodology is a critical but often overlooked factor in range and noise immunity. The MS and HS products utilize a true serial data stream rather than the PWM schemes employed

Encoder Comparison Table	
Manual Address Encoders	
Advantages High number of button inputs	**Disadvantages** Low-security fixed code Confusing manual addressing Low number of addresses PWM data output High security vulnerabilities
"Rolling Code" Encoders	
Advantages Highly secure Eliminates manual address settings	**Disadvantages** Low number of button inputs Encoder and decoder can become unsynchronized Difficult or impossible to create relationships Security vulnerabilities
Linx Encoders	
Advantages High number of button inputs Highly unique (MS) Highest security available on the market (HS) Eliminates manual address settings Allows for associative relationships Cannot unsynchronize Serial data output Encoder ID is output by the decoder Latched or momentary outputs (MS) External transmitter and receiver control lines	**Disadvantages** Slightly higher cost for some basic applications Security vulnerabilities (MS only)

Figure 8: Encoder Comparison Table

Baud Rate Selection

SEL_BAUD0 and SEL_BAUD1 are used to select the baud rate of the serial data stream. The state of the lines allows the selection of one of four possible baud rates, as shown in Figure 9.

Baud Rate Selection Table		
SEL_BAUD1	**SEL_BAUD0**	**Baud Rate (bps)**
0	0	2,400
0	1	9,600
1	0	19,200
1	1	28,800

Figure 9: Baud Rate Selection Table

The baud rate must be set before power up. The encoder will not recognize a change in the baud rate setting after it is on.

Latch Mode

The MS Series decoder has two output options based on the state of the LATCH line. If it is low, then the data lines are momentary, meaning that they are only high for as long as a valid signal is received. Once the signal stops and the decoder times out, the lines are pulled low.

If the LATCH line is high, the decoder pulls a data line high upon reception of a valid signal and holds it high until the signal is received a second time, at which point the decoder pulls it low. The decoder must see a break and time out between valid transmissions before it toggles the outputs. The minimum required time-out periods are listed in the Receive Mode section.

Receiver Control Mode

If the RX_CNTL line is pulled high when the decoder initially powers on, then the decoder enters Receiver Control Mode. Once in this mode, the RX_CNTL line becomes an output that can be attached to the PDN or V_{CC} line of a Linx receiver or a similar input on another receiver. This allows the decoder to power down the receiver when it is not required, thereby reducing current consumption and prolonging battery life. The decoder draws full current in this mode, but an active receiver typically draws much more than the decoder, so a savings is realized.

The decoder activates the receiver for approximately one packet's time plus 10ms for the receiver to power up, so the actual "on" time depends on the baud rate chosen by the user. This time can be calculated in milliseconds as (60/Baud Rate)(1000) + 10. The "off" time is nine times the "on" time, resulting in a 10% duty cycle, greatly reducing the receiver's current consumption. However, there may be a lag time from when the encoder activates to when the decoder responds. The decoder enters Receive Mode when it sees a valid packet, so there would only be a lag for the first packet. This can be reduced by selecting a higher baud rate.

If this feature is not going to be used, then this pin should be tied to ground. If it is tied to V_{CC}, then the decoder will create a short when it pulls the line to ground while trying to power down the receiver. This mode is appropriate for receivers that have a high internal pull-up resistance, such as those offered by Linx. If the intended receiver does not have a pull-up, then a 100kΩ or larger resistor to V_{CC} can be added to the RX_CNTL line to activate this mode.

Typical Applications

The MS decoder is ideal for replicating button presses for remote control applications. An example application circuit is shown in Figure 10.

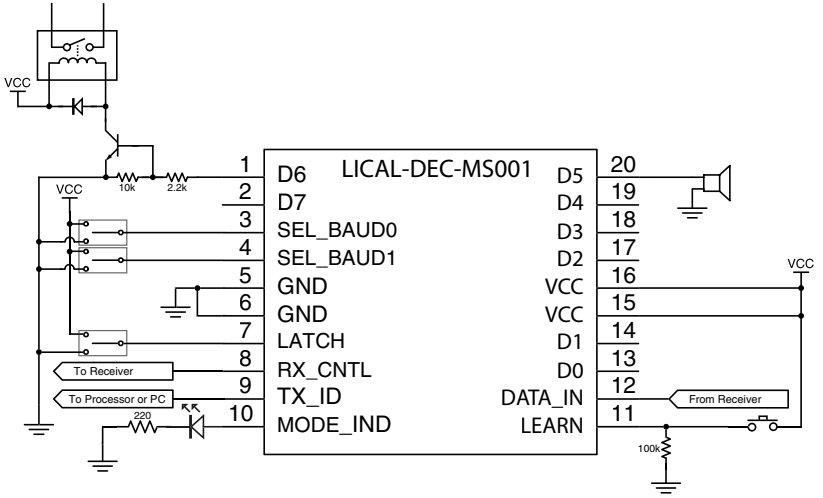

Figure 10: MS Series Decoder Application Circuit

SPDT switches are used to select the baud rate and set the latch mode so that pull-down resistors are not needed.

The RX_CNTL line can be connected to the PDN line of the receiver or it can be connected directly to ground.

TX_ID can be connected to a microprocessor or a PC to record the transmitter identity. Application Note AN-00156 has sample code that reads the transmitter ID and displays the ID number on a LCD screen.

An LED indicator is attached to the MODE_IND line to provide visual feedback to the user that an operation is taking place. This line sources a maximum of 25mA.

The LEARN line is connected to a button that pulls the line high when pressed. Since the line does not have an internal pull-down resistor, a 100kΩ resistor is used to pull the line to ground when the button is not pressed.

The DATA_IN line is connected directly to the data output of the receiver.

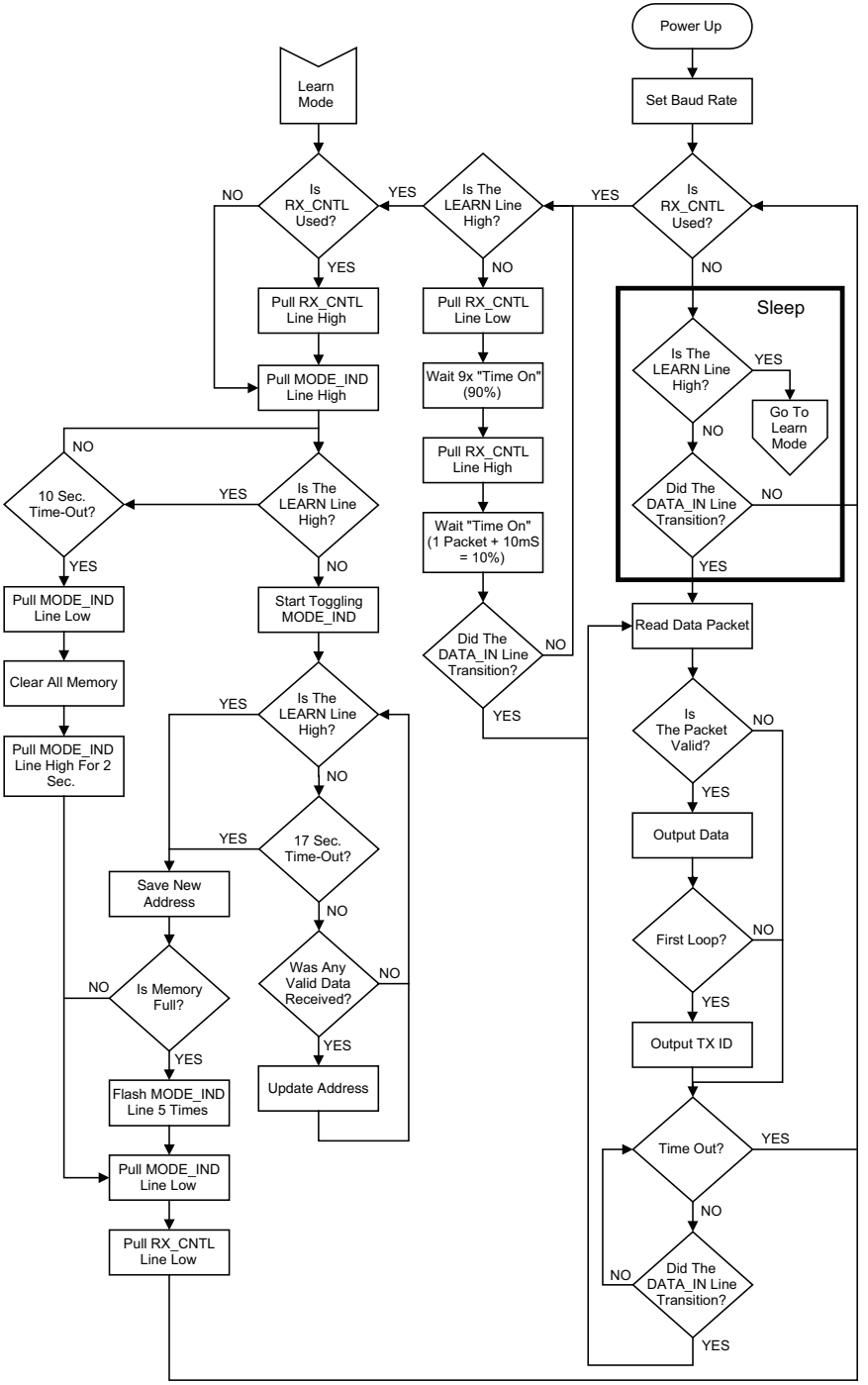

Figure 11: MS Series Decoder Flowchart

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